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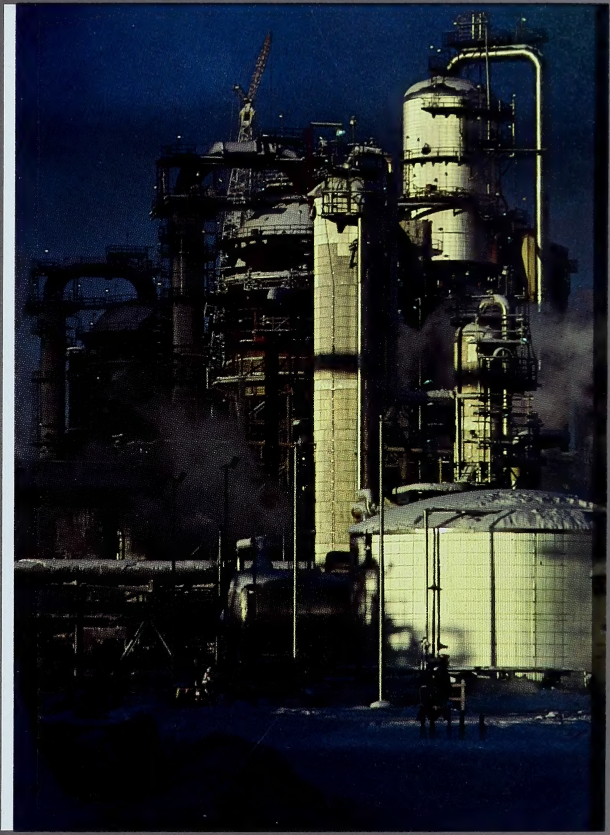
Energy Alberta



Energy Resources Conservation Board
Review of Alberta Energy Resources in 1984

With its vast oil, gas, oil sands, coal and hydro resources, Alberta is a virtual storehouse of energy. Development and production of these resources has been the major economic driving force of the province for more than three decades. The energy industry makes the largest contribution to Alberta's Gross Domestic Product and is the major source of revenue for the Provincial Government. Directly or indirectly, the energy industry affects all Albertans.

This is the third in the "Energy Alberta" series published by the Energy Resources Conservation Board (ERCB) to provide readers with a broad overview of the industry. This year we have added a section on the role of the ERCB in the development of the provincial energy resources, with particular emphasis on our activities during 1984.

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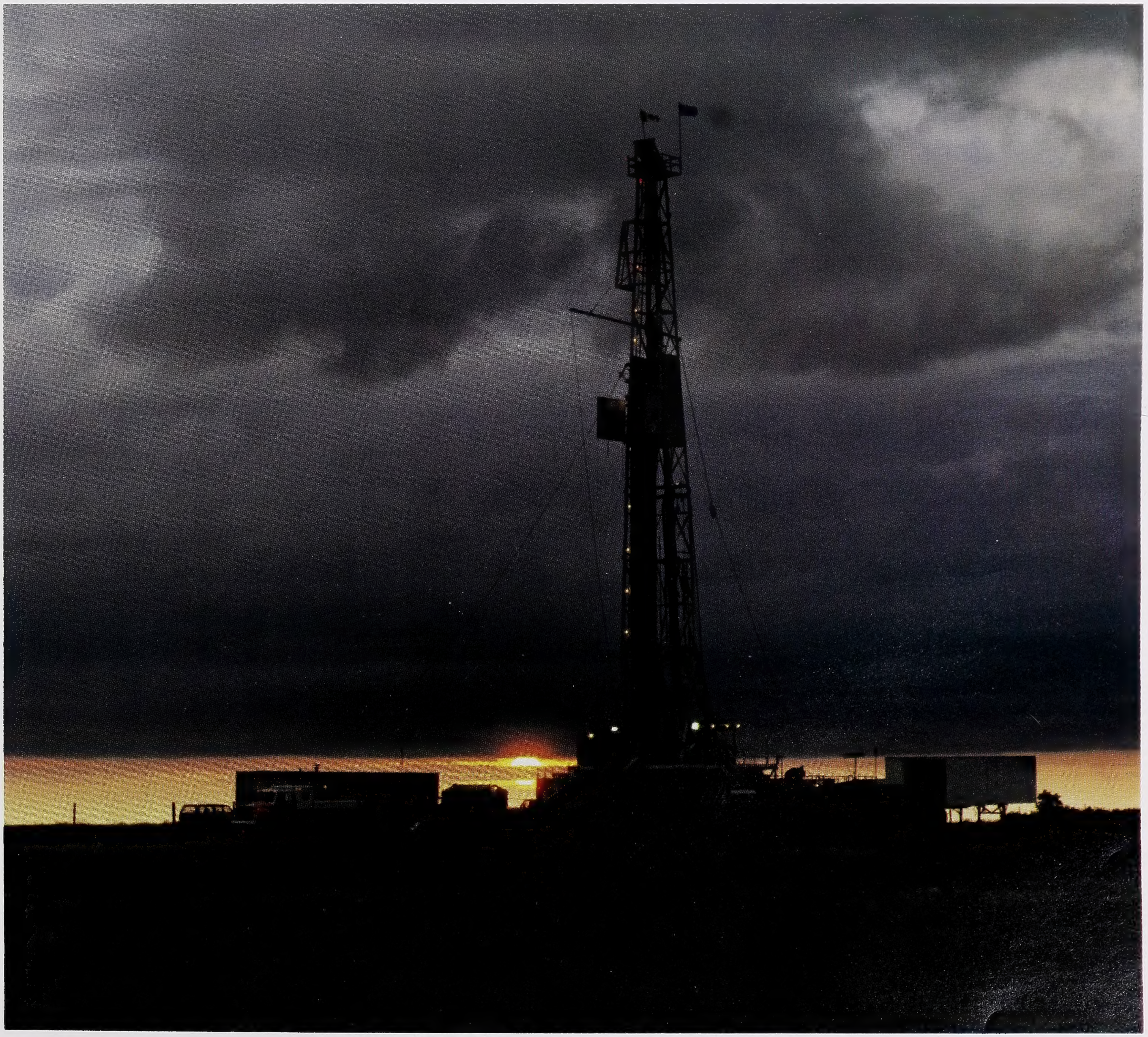


Enerfax

...a random selection of energy facts

The work of the Alberta energy industry produces a wide range of interesting yet relatively little known facts. We have assembled a sample that the reader may find interesting.

Oil

In 1984, Alberta's 17 600 oil wells produced 164 000 cubic metres per day of crude oil, for an average production of 9.3 cubic metres (59 barrels) per day, per well. In contrast, the average daily production rate per well in the United States was 14 barrels, and in Saudi Arabia was 8200 barrels.

Gas

The ERCB has identified some 17 800 separate natural gas accumulations in Alberta. About 94 per cent are very small and feed only one or two wells. One hundred and forty pools account for more than half of provincial gas reserves, and 1000 pools account for three quarters. At present, 5500 gas pools are on production.

Oil Sands

In 1984, the two oil sands mining and upgrading projects in the Fort McMurray area produced 7.8 million cubic metres of synthetic crude oil, or 10.4 per cent of the province's total oil production. These two plants employ about 7000 persons, equal to all the people working in forestry in the province.

Coal

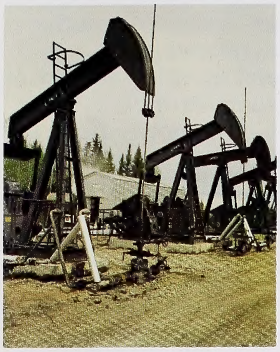
Alberta coal companies delivered 4.9 million tonnes of coal to British Columbia ports, during 1984, for shipment to offshore markets. The coal was transported in unit trains with an average of 98 cars per train, each car containing 90 tonnes of coal. The 1984 deliveries required 550 trains and, if lined up end-to-end, those trains would extend from Calgary to Vancouver.

Hydro

The 11 hydro plants on the Bow River system, and the 2 on the Saskatchewan River system, supplied 5 per cent of Alberta's electric energy requirements in 1984. The first Bow River dam — the Horseshoe Dam west of Calgary — was constructed in 1911 and still operates today.

Energy Highlights

...an overview of Alberta's energy resources in 1984



For the energy industry, 1984 proved to be a period of both encouragement and disappointment. On the positive side, production of energy resources (oil, gas, oil sands and coal) increased by about 5 per cent and revenues reached a new record of $25 billion. Increased cash flow, coupled with favourable policies and oil market opportunities, resulted in a substantial increase in drilling, both in the search for oil and in the development of conventional and oil sands reserves.

On the negative side, several of the underlying problems facing the industry remained at year end. While production of gas increased during the year, export markets continued to be restrictive and production remained substantially below its full potential. World-wide problems in the petrochemical industry did not lessen during 1984 and Alberta producers continued to have difficulty marketing their products. The situation was similar with respect to coal. While a new mine was placed on production in 1984, and total coal production increased, existing mines continued to have difficulty finding off-shore markets and a number of proposed new mining projects were deferred.

Here are brief comments on each energy sector:

Oil, Gas and Oil Sands

The ERCB issued 7176 well licences, 45 per cent more than in 1983, and the highest number since the 1980 record of 7440.

30 per cent more wells were completed than in 1983.

70 per cent of the successfully completed wells were for the production of oil, as compared to 30 per cent in 1980.

A combination of development-sensitive government policies provided special incentives for oil development, including relaxed qualification for higher oil prices, increased availability of royalty relief, and higher basic well allowables.

In situ oil sands development in the Cold Lake, Elk Point and Peace River areas continued to expand rapidly. Almost 20 per cent of the well licences issued in 1984 were for experimental or commercial oil sands projects.

Gas markets remained depressed, although sales increased significantly during the last half of the year following a reduction in gas prices in the export market.

Gas production remained substantially below full potential because of limited export markets.

Coal

Total coal production increased 5 per cent; most of the growth occurred in the subbituminous coal used for the generation of electric energy in Alberta.

Hydro and Electric Energy

Alberta's electric energy requirements increased by almost 9 per cent.

Because Alberta's future electric energy requirements are not expected to increase as rapidly as previously predicted, the construction of two large generating units has been delayed.

Alberta's Energy Stream

...supply and demand factors — 1984

Alberta is rich in energy resources. Exploration has identified major reserves of oil, gas, oil sands, coal and hydro. Development of these resources has been going on for several decades. Obviously, the development of a resource requires the installation of both production and transportation facilities. The production facilities vary depending on the nature of the resource being developed. For example, oil and gas production occurs through wells while coal is obtained by either surface or underground mining. Sometimes the resource transportation requirements are minimal (for example, where a coal-fired power plant is located adjacent to a surface coal mine) but more often they are of major importance because most of the energy produced in Alberta is delivered to markets located substantial distances beyond Alberta's borders.

The on-going development of Alberta's energy resources has required an expanding array of production and transportation facilities. Today, there are some 40 000 wells producing oil, gas and bitumen, 160 000 kilometres of pipelines crisscross much of the province, and several hundred gas processing plants dot the countryside, to name just three examples.

Not only is there a maze of production and transportation facilities, but there is also great variety in the markets served by Alberta's energy resources. In some instances the market is local; for example, an industrial plant using gas as a feedstock to manufacture fertilizer. Electric energy for the operation might be generated on site, or it might be purchased from a utility, with the generation taking place hundreds of kilometres from the plant. In most instances, however, the energy — particularly if it is oil or gas — is gathered by pipeline systems within the province, and then distributed to a variety of consumers both in and outside the province.

A further complication is the fact that some specific energy requirements can be satisfied by several different energy resources. For example, electric energy is currently generated from coal, gas and hydro. The extent to which each resource is utilized depends on the relative costs and the particular demand being served. Similarly, gas, oil, or electric energy may be used to satisfy residential or industrial fuel requirements and, again, the resource selected will depend on various factors, but price will likely be the major one. Because energy resources are interchangeable, it becomes essential to evaluate the demand for the resources on a composite as well as an individual resource basis.

In summary, the production and distribution of Alberta's energy resources is not only exceedingly complex, but it is subject to continual change. In the following pages, the hundreds, if not thousands, of separate energy stream flows that occurred in Alberta in 1984 have been consolidated to present a broad composite overview of energy production and uses. The energy stream flows are expressed in "exajoules" (EJ) — a very large unit of energy which can be applied to all energy forms whether they are solid, liquid, or gaseous. One exajoule is equivalent to approximately 160 million barrels of oil. That much oil would meet Alberta's current transportation needs for 20 years.

How much primary energy does Alberta produce? In 1984, total production of all forms of energy was about 6.2 exajoules. Oil and gas accounted for almost 85 per cent, in about equal portions. Coal and bitumen contributed virtually all of the remaining 15 per cent, although hydro resources made a modest contribution in the generation of electric energy.

What then happened to this 6.2 exajoules of primary energy? It flowed in and from Alberta in diverse ways. (Chart 1 on page 6, is a simplified representation of the main flows in the Alberta energy stream.)

About 4.7 of the 6.2 exajoules were delivered to markets without any additional processing — 4.3 to markets outside the province and 0.4 to local markets. Gas and oil were about equally important in the energy stream leaving the province. Deliveries to local markets were almost entirely gas, which was used primarily to heat homes and commercial establishments, and for industrial operations. Canadian markets accounted for about two-thirds of the total out-of-province deliveries, with the remaining one-third being delivered to markets in the United States.

Approximately 1.2 exajoules of primary energy were delivered to Alberta plants for further processing. The principal Alberta processing operations were; upgrading bitumen to synthetic crude oil, refining oil to manufacture petroleum products, and manufacturing petrochemicals from gas and natural gas liquids (NGLs). The products obtained from this processing were delivered both to consumers in the province and to markets in other provinces, as well as to many other parts of the world. Petroleum products from Alberta refinery operations were largely consumed in Alberta; however, about one-third was delivered to neighbouring provinces. In contrast, most of the petrochemicals manufactured in Alberta, from provincial energy resources, were delivered to worldwide markets.

About one-third of an exajoule was used in the generation of electric energy, with coal-fired thermal power plants accounting for 91 per cent. All the electric energy generated in Alberta is delivered to Alberta consumers. This province neither imports nor exports significant amounts of electrical energy.

The energy consumed in Alberta in 1984 totalled 0.9 of an exajoule, of which 0.4 was gas, which didn't require further processing, 0.4 was processed into such products as petroleum and petrochemicals, and 0.1 was electric energy.

Alberta's Energy Stream — 1984

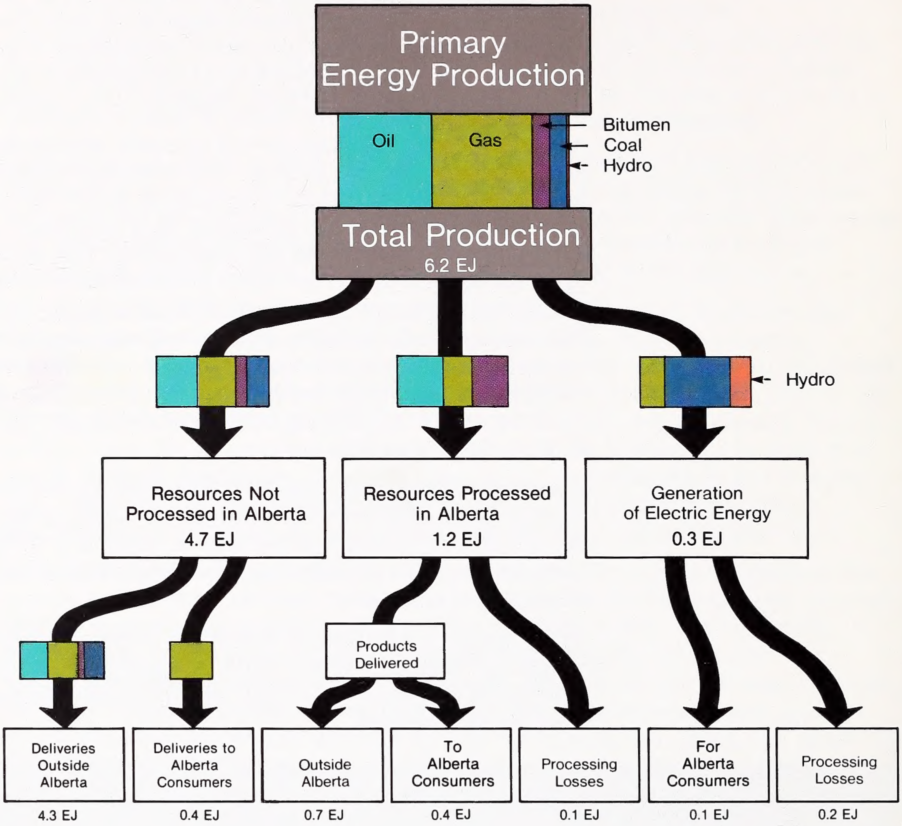
To assist the reader in following the story of Alberta's energy resources we have assigned a specific colour to each resource, as shown below. To follow a particular resource through the publication — for example, gas (colour; green) — watch for charts, and graphs illustrated in that colour.

Chart 1

Production	**EJ**	**%**
Oil	2.5	40
Gas	2.7	44
Bitumen	0.5	8
Coal	0.5	8
Hydro	0.01	
Total	**6.2**	**100**

Distribution		
Resources not Processed in Alberta	4.7	76
Resources Processed in Alberta	1.2	19
Resources Used to Generate Electric Energy	0.3	5
Total	**6.2**	**100**

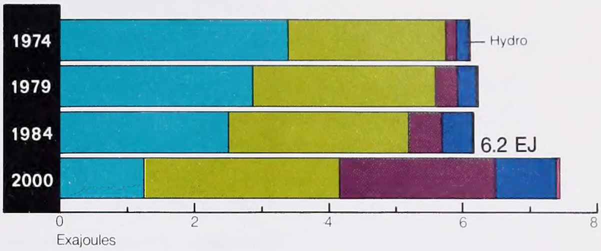
Deliveries		
Deliveries to Alberta	0.9	15
Deliveries Outside Alberta	5.0	80
Conversion Losses	0.3	5
Total	**6.2**	**100**



Charts 2 through 6 provide a comparison of 1984 energy flows with those of 1979 and 1974. They also indicate the ERCB's forecast of what those flows may be in 2000. Additional information on the year 2000 may be found in the Futures section, page 22.

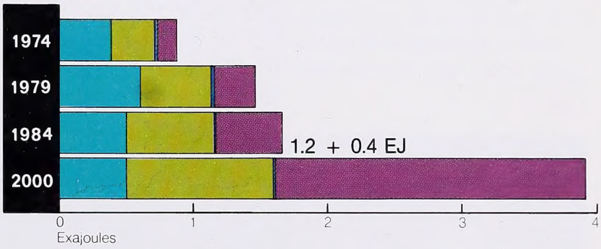
2 Alberta's Total Primary Energy Production

Conventional crude oil is declining in importance, while bitumen and coal are becoming more important. In 1974, oil accounted for 55 per cent of primary production as compared to 40 per cent in 1984. It is projected for 15 per cent in 2000. In contrast, bitumen and coal accounted for 15 per cent in 1984, but are projected for 40 per cent in 2000.



3 Alberta Hydrocarbon Energy Resource Requirements

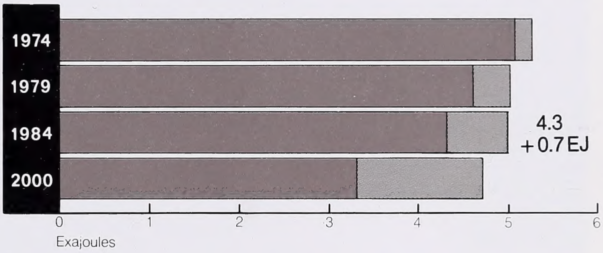
Hydrocarbon resources are used as feedstock (1.2 EJ) and as gas for heating (0.4 EJ). The doubling by 2000 is due to increased volumes of bitumen to be upgraded.



4 Energy Resources Shipped Out of Province

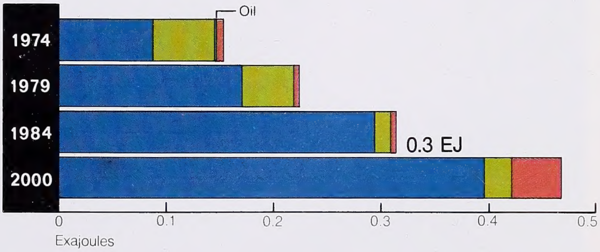
Most of the energy produced in Alberta is shipped out of the province in unprocessed form (4.3 EJ). ERCB believes that more of Alberta's energy will be processed in the province in the future.

▨ Unprocessed
▨ Processed



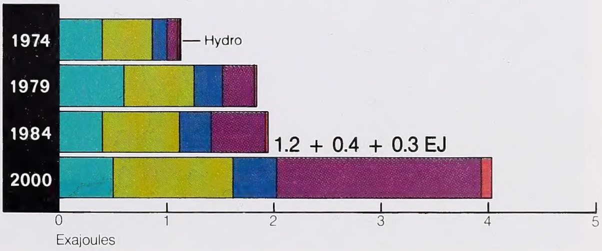
5 Electric Energy Resource Requirements

Coal is the dominant energy resource used for generation of electric energy and will continue to be for the foreseeable future. Gas and hydro energy also make contributions, especially in periods of peak electrical demand.



6 Total Alberta Energy Resource Requirements

The current Alberta need, of almost 1.9 exajoules, is expected to more than double by the year 2000, primarily because of the increased volume of bitumen which will be upgraded (partially processed) in the province.



Oil, Gas and Oil Sands

...in the Alberta energy stream

Pages 8 through 13 provide an analysis of Alberta's oil, gas, and oil sands resources, including drilling and production, experimental project activity, how much of each resource we have developed now, and how much we expect to produce.

Conventional Crude Oil

The industry continued to concentrate its activities on oil prospects in 1984, resulting in an increased number of successful exploratory and development oil wells being drilled in the province. Although no major new oil pools were discovered, the additions to reserves from new discoveries, from re-evaluations, and from enhanced recovery operations, were near the record level for the last 10 years. Oil productivity additions, from conventional reserves, exceeded expectations.

These increases in reserves and productivity can be partially attributed to various changes in Federal/Provincial pricing policies, which continued to expand the categories of production eligible for the highest oil price — the New Oil Reference Price (NORP). Additional help came from such changes as increasing the basic well rate assigned to new wells — from 5 to 8 (or more) cubic metres per day — and from adding a 1-year royalty exemption for certain new exploratory wells.

The recently-signed Western Accord, and continuing deregulation of the oil industry, should sustain activity in the conventional oil sector. However, during the next year, limitations in the capacity of the interprovincial pipeline network may require some restraints on production.

Gas Removal

In November 1984, the Alberta Government enacted a new Gas Resources Preservation Act. Several changes were brought about by this new legislation. The most significant was the expansion of the public interest criteria upon which the ERCB must evaluate applications for removal of gas from the province. Applicants proposing to remove gas now are required to provide information on the economic costs and benefits to Albertans of the proposed sale, including evidence that the proposal will not result in the loss of any existing market. The ERCB has received several applications for gas removal since the new Act was proclaimed, largely for short-term, small-volume, direct sales to American and Eastern Canadian industries and utilities.

Petrochemicals

During 1984, the ERCB issued industrial development permits for projects by Cancarb Limited for a major expansion to its thermal carbon black plant at Medicine Hat, and by Palmer Ranch (1984) Ltd. for an anhydrous ammonia plant to be constructed on the site of the former Gulf Pincher Creek gas processing plant. Also, Alberta Gas Chemicals Ltd. applied for permission to build an anhydrous ammonia plant adjacent to its methanol production facilities at Medicine Hat.

Ethane Extraction in the Field

Three field ethane extraction plants, approved by the ERCB in 1983, are currently under construction, and two more were applied for and approved in 1984.

Oil Sands

There was a significant increase in oil sands exploration and development during 1984.

Phases 3 and 4 of Esso's Cold Lake cyclic steam injection project were approved by the ERCB. These two phases are particularly significant in terms of capital investment, employment, and the production of crude bitumen. This five-phased project eventually will be capable of producing 9000 cubic metres of crude bitumen per day.

The ERCB also approved an application by Shell to expand its 500 cubic-metre-per-day crude bitumen project in the Peace River area to a commercial 1600 cubic-metre-per-day rate. This 636-well project will utilize a unique variation of the cyclic steam method and is forecast to produce 17.5 million cubic metres over 30 years.

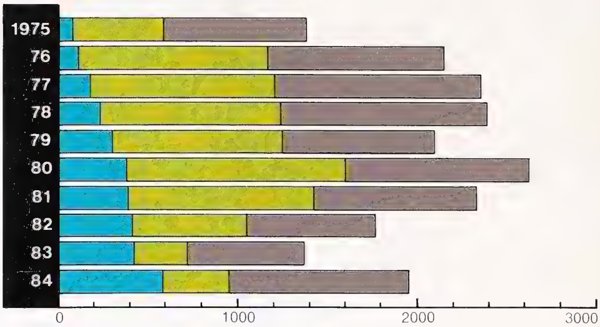
Syncrude received approval to expand its surface mining, extraction and upgrading project near Fort McMurray from 17 300 to 22 000 cubic metres per day of synthetic crude oil. A hydrocracker will improve the yield of synthetic crude oil from the bitumen, and a sulphur clean-up unit will reduce sulphur dioxide emissions.

Also in 1984, the Alberta Oil Sands Technology and Research Authority (AOSTRA) was given approval to test a novel technique for improving the extraction of oil sands. The new technique involves large-diameter mine shafts, underground tunnels, and horizontally drilled steam-injection and drainage holes.

7 Exploratory Wells Drilled

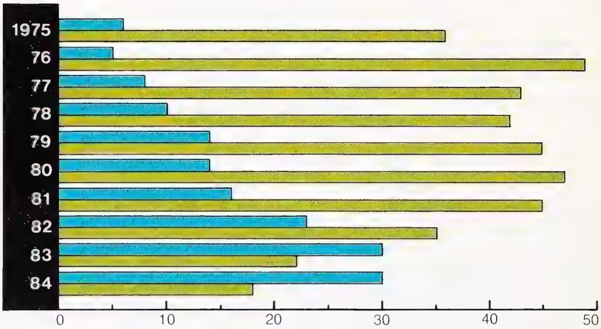
Exploratory drilling increased 42 per cent from 1983 due to improved industry cash flow and stronger oil markets.

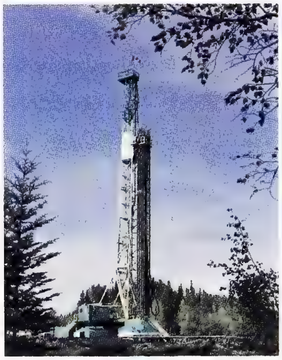
▨ Abandoned and Other



8 Completion Percentage — Exploratory Wells

Almost one-half the exploratory wells were successful, with two-thirds completed for oil and one-third for gas.

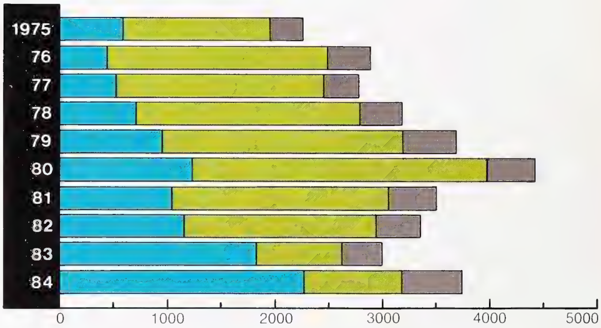




9 Development Wells Drilled

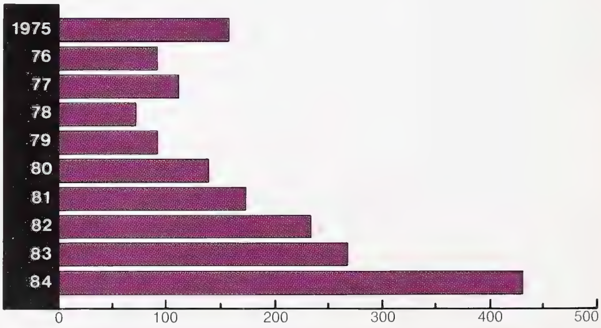
Development wells are those drilled to increase the productive capacity of a producing or producible pool. This drilling increased 25 per cent from 1983. Well completions were 25 per cent for gas, 61 per cent for oil.

▨ Abandoned and Other



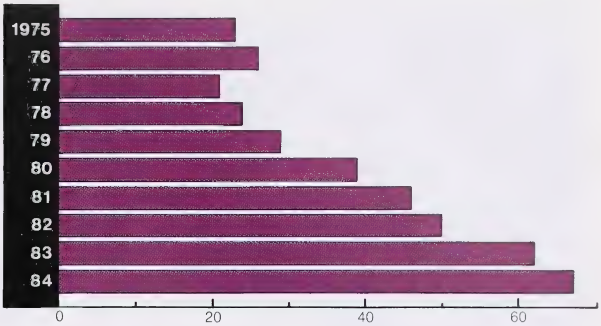
10 Experimental Wells — Oil Sands

Experimental drilling increased 61 per cent from 1983, to 431 wells, reflecting attractive prospects and favourable markets.



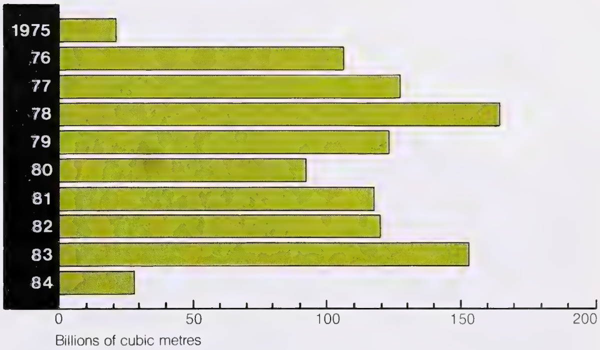
11 Experimental Projects

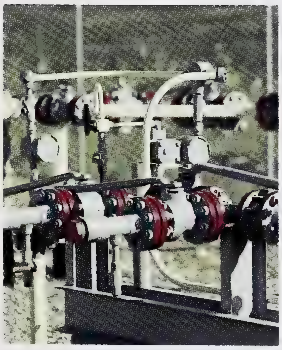
The number of experimental projects increased 8 per cent from 1983.



12 Additions to Established Marketable Gas Reserves

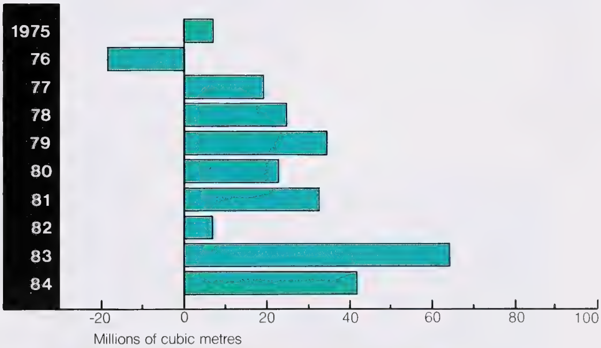
The 1984 additions were substantially below the long-term average, reflecting reduced exploration and development of gas prospects.





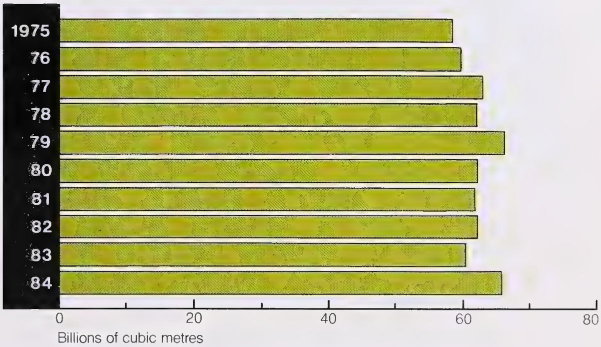
13 Additions to Established Oil Reserves

Additions remained relatively high, largely due to extensions, re-evaluations of previous discoveries, and new enhanced recovery projects.



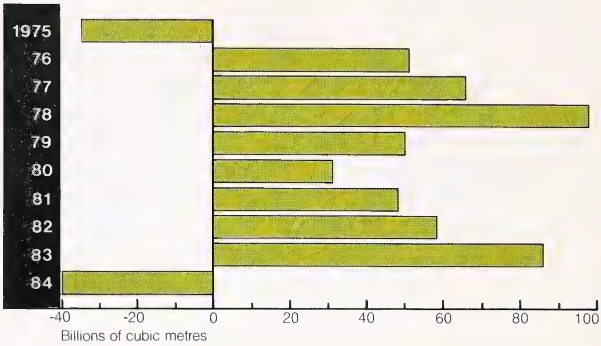
14 Gas Production

Gas production recovered from 1983 levels, largely because of lower export prices and improving markets.



15 Changes in Established Gas Reserves

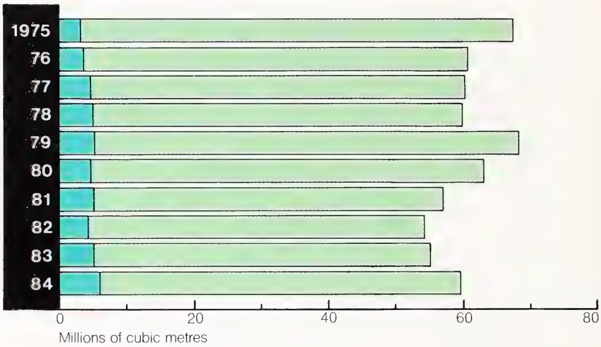
Remaining gas reserves declined, with additions equal only to 40 per cent of total gas produced.



16 Conventional Crude Oil Production

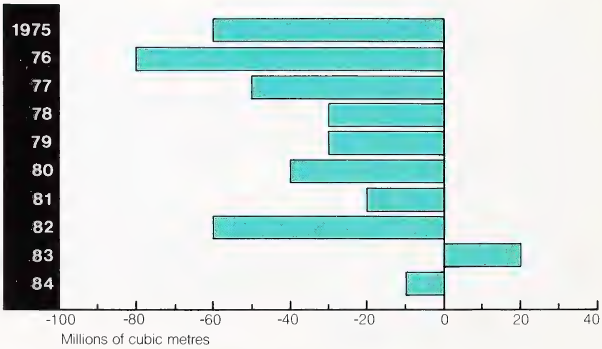
Production recovered further in 1984, to the highest level since 1980.

▨ Heavy Oil
▨ Light and Medium Oil



17 Changes in Established Conventional Crude Oil Reserves

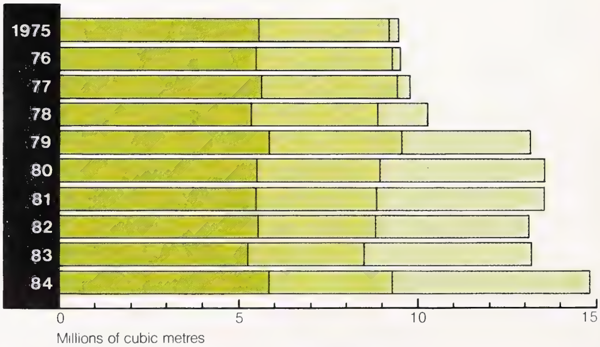
Reserve additions again failed to replace production, but by less than in most recent years.

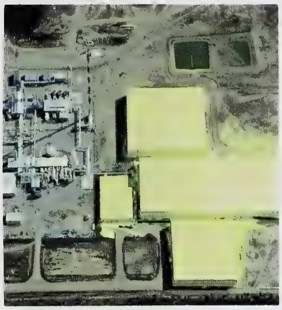


18 Natural Gas Liquids Production

Increased gas production, and more complete removal of liquids from natural gas streams, resulted in all-time-high natural gas liquids production.

▨ Propane
▨ Butanes
▨ Ethane

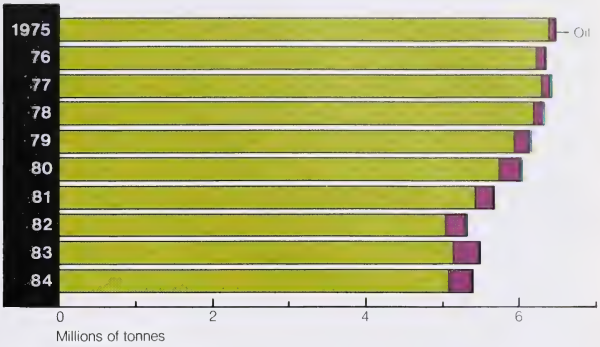




19 Sulphur Production

Sulphur production was somewhat less than in 1983 due to reduced throughput at sour gas plants, and to shutdowns at oil sands plants.

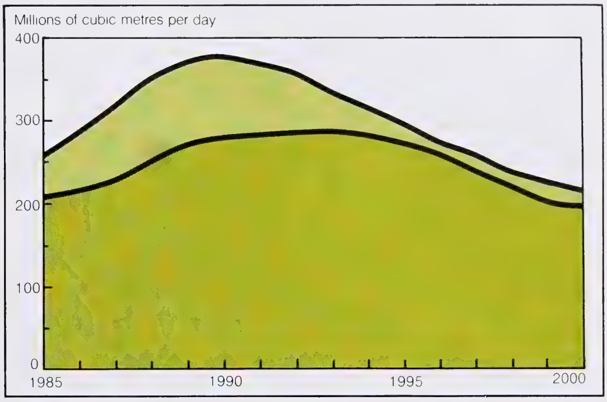
- 🟩 Gas Plants
- 🟪 Oil Sands Plants
- 🟦 Refineries



20 Forecast Gas Supply

Gas production recovered slightly in 1984, but remained substantially less than potential productive capacity, and only 80 per cent of developed capacity. The ERCB expects surplus capacity to continue until the early 1990s.

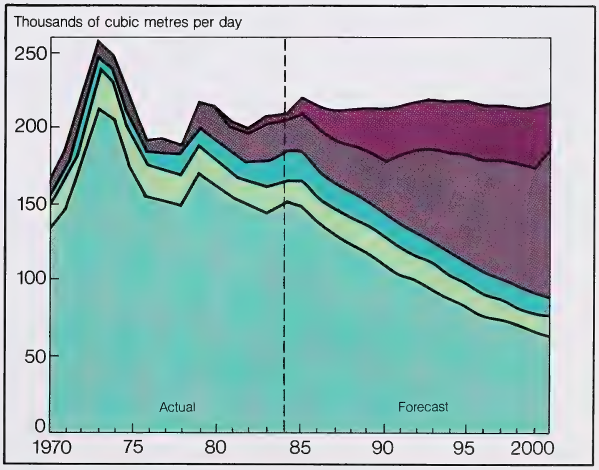
- 🟫 Productive Capacity
- 🟨 Marketable Gas Production



21 Crude Oil (and Equivalent) Supply

ERCB's review indicates that the continued decline in conventional crude capacity (4 to 5 per cent per year) will be offset by increased production of synthetic crude oil and bitumen.

- 🟪 Crude Bitumen
- ▨ Synthetic Oil
- 🟦 Heavy Oil
- ⬜ Pentanes Plus
- 🟩 Light-Medium Oil



Management of Oil, Gas and Oil Sands Resources

...in the Alberta energy stream

Since energy resources are non-renewable, it is important to ensure that they are developed and produced in a way that will ensure optimum recovery and avoid waste. Indeed, that objective is one of the major responsibilities assigned to the ERCB under the Energy Resources Conservation Act, and was the basic reason for establishing the Board almost 50 years ago. The statute requires the ERCB to "effect the conservation of, and to prevent waste of, the energy resources of Alberta" and provides ERCB with substantial powers to ensure achievement of that objective.

Oil and Gas

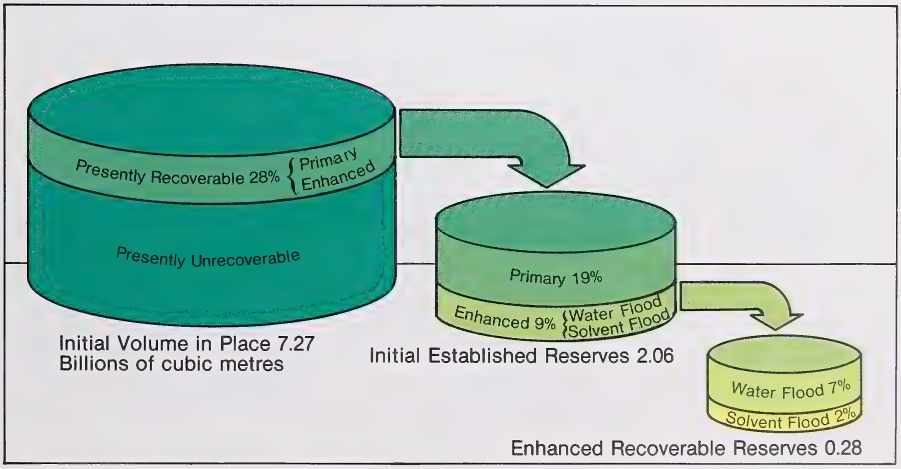
Only a fraction of the oil found in a reservoir can be recovered. That fraction is dependent upon various factors, including the quality of the reservoir, and the ability of natural forces, such as water, to drive the oil to the producing wells. Oil recovery by natural forces (normally called "primary recovery"), varies considerably, but the average for Alberta pools is 19 per cent.

Research and experience have proven that primary recovery can be significantly increased by injecting fluids into the reservoir, thereby helping push the oil to the producing wells. (These are known as "enhanced recovery" programs.) There are more than 500 enhanced recovery operations in Alberta's producing oil pools which have increased the average recovery rate from 19 to 28 per cent. The remaining 72 per cent of the oil, which is unrecoverable with today's technology and economic factors, presents a future challenge for the researchers.

Enhanced recovery operations frequently are expensive to implement because of high start-up costs and delayed returns. Favorable royalty and tax provisions can assist in implementing enhanced recovery programs. Various federal and provincial incentives currently encourage enhanced recovery activities, particularly those involving the injection of solvent, or thermal recovery techniques. During 1984, 10 new projects of this kind were approved by the ERCB and four became operational.

Gas — known as "solution gas" — is unavoidably produced with crude oil. The ERCB ensures that this solution gas is gathered and marketed rather than being wasted by flaring. The conservation record in Alberta has been

22 Crude Oil Reserves



good, and more than 90 per cent of this solution gas is regularly conserved.

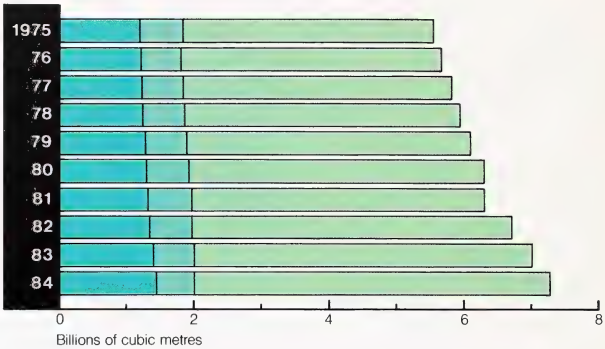
Oil Sands

Extensive research and experimentation is being conducted to develop techniques for optimizing recovery from oil sands utilizing wells. More than 60 experimental projects now are being conducted. Several successes have led to ERCB approval of a number of commercial projects in which the bitumen is being recovered through the injection of steam and other constituents into oil sands formations.

23 Conventional Crude Oil Resources

The portion of the oil in place, which is presently unrecoverable, offers a challenge to the industry. Just a 1 per cent increase in the average recovery would increase the recoverable reserves by 70 million cubic metres. However, the technical problems are difficult and progress has been slow.

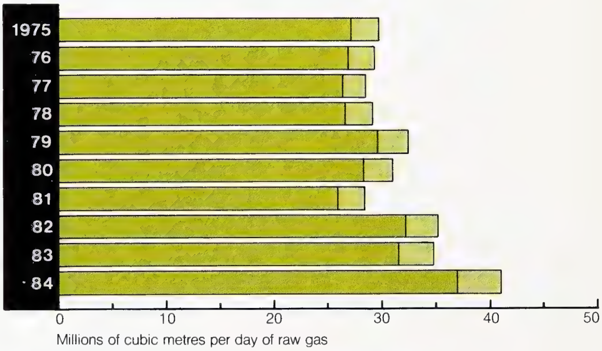
🟦 Primary Recovery
🟦 Enhanced Recovery
🟦 Unrecoverable



24 Solution Gas Production

With few exceptions, the gas that is unavoidably produced with oil is gathered, conserved and marketed.

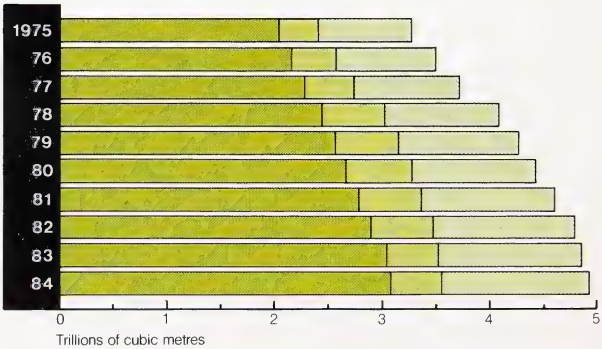
🟩 Conserved
🟩 Flared



25 Natural Gas Resources

About 80 per cent of the natural gas in place is recoverable, as compared to only 28 per cent for conventional crude oil. Considerable shrinkage occurs with natural gas because of the removal of natural gas liquids (NGLs), and impurities such as hydrogen sulphide.

🟩 Marketable Gas
🟩 Shrinkage (Includes NGLs, H_2S, CO_2)
🟩 Unrecoverable



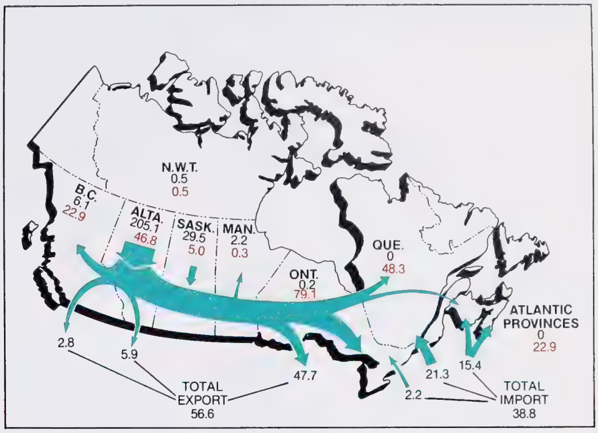
26 Movements of Crude Oil (and Equivalents)

(Thousands of Cubic Metres Per Day)

Alberta oil is marketed mainly in Alberta, Eastern Canada and the USA. During 1984, Alberta produced 84 per cent of Canada's total oil production.

Net Product Export	
Atlantic Provinces	-3.5
Ontario	+ 10.1
Other	+ 1.1
Total Canada	+ 7.7

Legend	
Production	205.1
Consumption	46.8

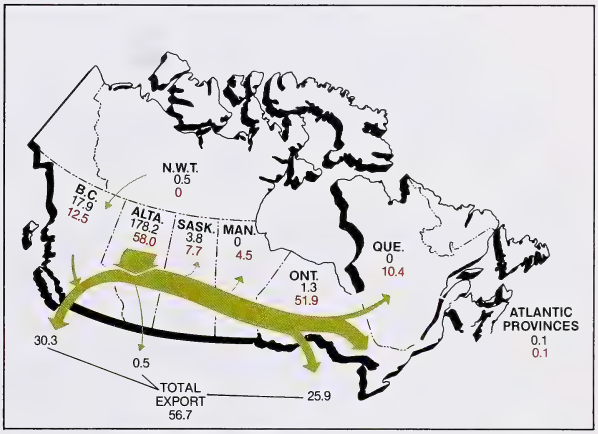


27 Movements of Natural Gas

(Millions of Cubic Metres Per Day)

Alberta produced 88 per cent of Canada's total gas production in 1984. Canadian gas production was marketed; 27 per cent in Alberta, 31 per cent in Eastern Canada, and 28 per cent in the USA.

Legend	
Production	178.2
Consumption	58.0



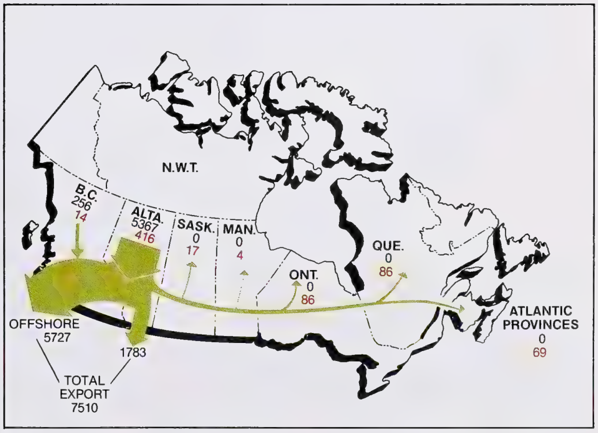
28 Movements of Sulphur

(Thousands of Tonnes Per Year)

Alberta produced 95 per cent of Canada's total sulphur production in 1984. Sales from Canadian production were distributed; 22 per cent to the USA and 70 per cent to other countries.

Deliveries from Inventory 2579

Legend	
Production	5367
Consumption	416



Coal

...in the Alberta energy stream

The performance of the coal industry in 1984 was somewhat irregular, although strength in several world markets offered encouragement for the future.

The oversupply of coal in the export market led to a continued slow-down in the development of new Alberta coal mining projects. However, other projects which were already underway provided increased activity during 1984. For example, Manalta's new Gregg River coal mine, near Hinton — which first began shipping metallurgical coal to Japan in 1983 — increased its shipments in 1984 and is now projected to reach full production of 2 million tonnes per year in 1985. TransAlta's Highvale mine — the largest coal mine in Canada — increased its production by 15 per cent to more than 11 million tonnes, and Union Oil's Obed Mountain thermal coal mine, also near Hinton, first began shipping coal in August of 1984. This mine is designed to produce 3 million tonnes annually.

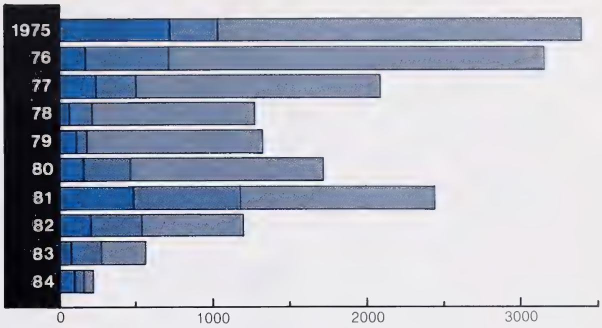
Alberta's total 1984 coal production increased by 5 per cent, to 22.7 million tonnes of marketable coal. Of that amount, 7.2 million tonnes was produced by five surface mines and one underground mine, located in the Foothills and Mountain regions of the province. The remaining 15.5 million tonnes was produced in the Plains region by six major and seven smaller mines.

Most of the coal produced in the Foothills and Mountain regions was exported, with only a small amount being used in Alberta for electric energy generation. However, virtually all the coal produced in the Plains region was used for generating electric energy for provincial use.

29 Coal Exploration — Holes Drilled

The economic recession, and a high ratio of reserves to production, resulted in a further decline in coal exploration. Drilling was largely related to the extension of existing mines in 1984.

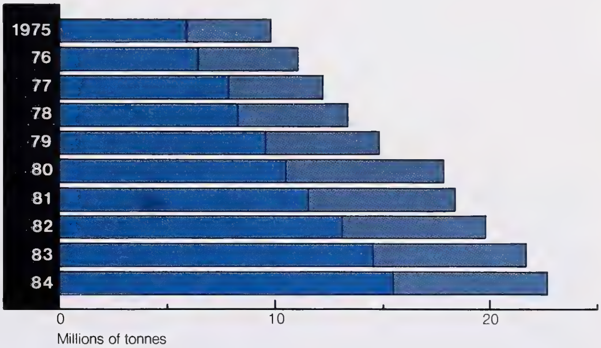
■ Mountains
■ Foothills
■ Plains



30 Coal Production

Output of bituminous export coal from new mines, and greater demand by Alberta's electric generating stations for subbituminous coal, resulted in a 5 per cent increase in coal production for the year.

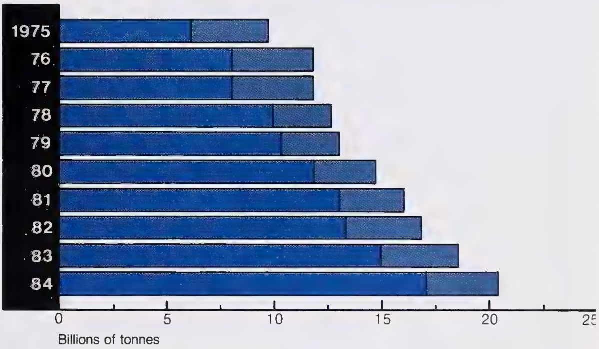
■ Subbituminous
▦ Bituminous



31 Coal Reserves

Development drilling added further reserves during the year. At the 1984 production rate, the currently established reserves would last for 840 years.

■ Subbituminous
▦ Bituminous

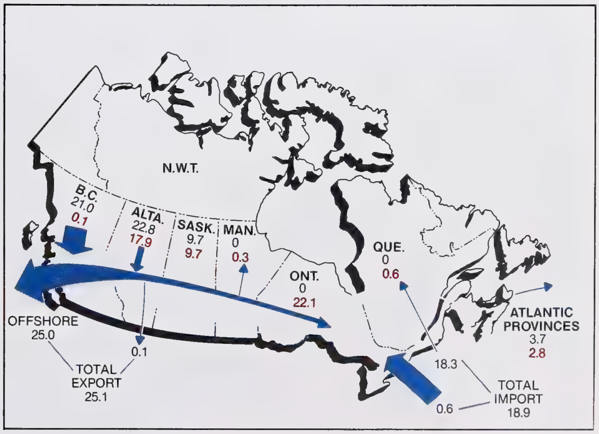


32 Movements of Coal
(Thousands of Tonnes Per Year)

Canada continued to enjoy a surplus in coal trade in 1984. Exports to Japan and Korea greatly exceeded imports into Eastern Canada from the USA.

Legend

Production	22.8
Consumption	17.9



Hydro and Electric Energy Generation

...in the Alberta energy stream

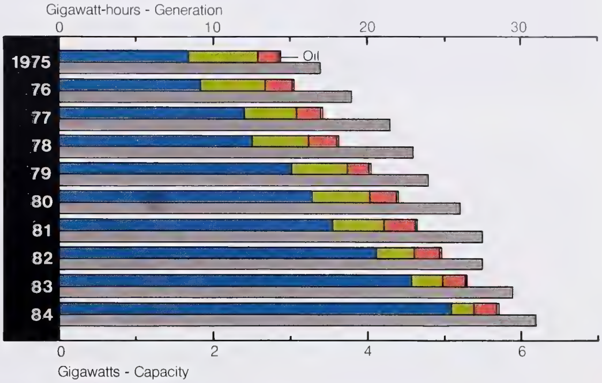
The impact of hydro and electric energy on the Alberta economy is explored here, with particular emphasis on the drop in overall activity, and the new interest in wind-powered electric generators.

The pace of applications to the ERCB — for approval of additions or alterations to generating and transmission facilities — slackened in 1984. This was largely due to the continued economic downturn in the province and the slower growth in electric energy demand. The ERCB received only 67 applications in 1984, compared to 110 in the peak year of 1982.

In March 1984, TransAlta Utilities Corporation commissioned the second 400-MW generating unit at its new Keephills station in the Lake Wabamun area west of Edmonton. However, the continued decline in forecasted electric energy load growth prompted the ERCB to initiate a review of the commissioning dates for the Sheerness and Genesee plants, which are presently under construction.

During 1984, the ERCB received several applications from Alberta farmers and ranchers for wind-powered electric generators with capacities ranging from 2 to 45 kW. In the past, a few such generators were installed to supply electric energy for the applicant's own requirements. However, one

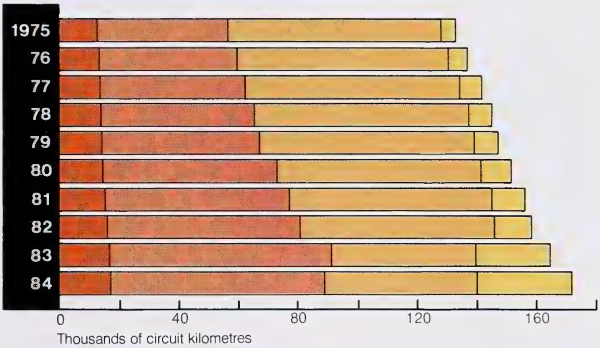
of the 1984 applicants sought approval to sell surplus energy generated by his wind-powered unit to an electric utility. This request resulted in a public hearing in March of 1984. As an outcome of that hearing the ERCB authorized the sale of such surplus energy to TransAlta Utilities Corporation for a trial period of 5 years, and made the same agreement available to other approved wind-powered generators. The ERCB also asked TransAlta to obtain technical and cost information on the operation and interaction of individually-owned, wind-powered generators with the total Alberta electric system.



33 Electric Generating Capacity, and Energy Generated

Electric energy production increased about as forecast, mainly to meet new industrial requirements in Alberta. System capacity increased through commissioning of another unit of the Keephills power plant.

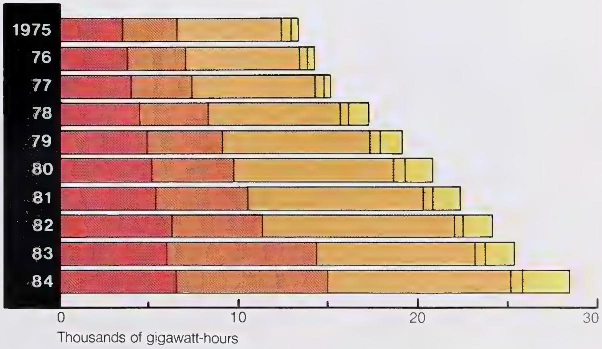
▨ Generating Capacity



34 Electric Transmission and Distribution Lines

Total length of transmission lines operated declined slightly as a result of decommissioning some older lines. Length of rural distribution lines continued to increase, mainly in the utility-owned category.

▨ Transmission (over 60kv)
▨ Sub-Transmission and Distribution (below 60 kv)
▨ Rural Electrification Association
▨ Utility Owned Farm



35 Alberta Electric Energy Markets

The importance of industrial markets increased substantially, reflecting stable residential and commercial demand and a large increase in industrial demand.

▨ Residential
▨ Commercial
▨ Industrial
▨ Transportation
▨ Industrial On-Site Generation

Outlook for Alberta's Energy Resources

...a perspective on energy in Alberta in the year 2000

As we approach the 21st Century, Alberta's economy will become more diverse and will likely be well established as the base for Canadian oil and gas management. Although the provincial economy will go through a maturing process, energy will continue to be its dominant feature in the year 2000. Production of oil, gas, oil sands, and coal still will contribute one-quarter of the provincial gross domestic product (GDP) at that time. However, the passage of time will result in changes to the present patterns of production and consumption based on declines in conventional oil and gas supplies, the development of new technologies for the recovery of resources, and an increased level of oil upgrading in the province.

The overall outlook suggests a growth of 20 per cent in primary energy production in this province by the year 2000. Notwithstanding modest new discoveries of oil, and the implementation of enhanced recovery processes, conventional oil production will have been cut in half due to the rapid depletion of the older pools which were discovered in the 1950s and 1960s. To offset this decline, greater emphasis will be placed on the development of oil sands reserves. Several large new plants will be in operation by 2000, and many smaller-scale oil sands projects will be recovering bitumen by various in situ methods. The oil industry will have become increasingly centred in northern Alberta, with its related service industry centralized in such communities as Bonnyville, Peace River, and Fort McMurray. The decline in conventional oil production likely will have some negative impact on smaller communities in central Alberta. However, the ERCB believes that the increasing need for service activities during the mature phases of conventional oil and gas production should sustain a degree of economic stability in these communities until well into the next century.

Bitumen and synthetic crude oil production will exceed conventional oil (and equivalent) production by the mid 1990s, and will represent 60 per cent of total oil supply in 2000, as compared to 16 per cent in 1985. However, total crude oil (and equivalent) supply should be much the same in 2000 as it is today.

To achieve this new balance, the oil industry will be challenged to modify its refining configuration throughout Canada. Upgraders for heavy crude oil and bitumen will be needed to make these oils suitable for marketing in Canada and abroad. Some upgraders no doubt will be integrated with existing refineries in the Edmonton area, but others — especially in the Cold Lake/Lloydminster region — may upgrade crude oil from bitumen recovered by in situ processes.

A growing Canadian market, and recovery from global recession by Canada's trading partners, will enhance the long-term demand for Alberta's energy resources and manufactured products. Energy demand in the province will continue to grow to supply the 3 million people who will be living here at that time, but the end uses of that demand will focus more on the industrial and transportation sectors. (Charts 36 and 37 respectively, show the end uses of Alberta energy in 1984, and the changes anticipated in those end uses by the year 2000.)

Additional pipeline capacity will have been installed by the year 2000, to transport these greater volumes of heavy oil, and to facilitate the transshipment of crude oil production from the Beaufort Sea, in the Northwest Territories.

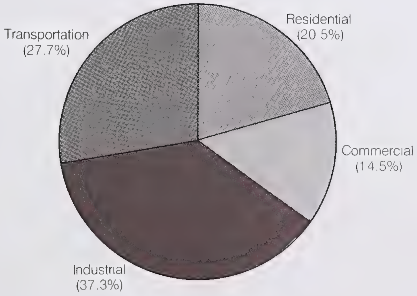
Although still vigorous, the Alberta gas industry also will have matured by the turn of the century. This will occur despite significant new gas discoveries anticipated for the period 1985-2000. Total gas production in 2000 will be less than 90 per cent of 1985 levels, having peaked in the early 1990s. Although declining supplies will have eroded our USA exports to less than one-quarter of current levels, Alberta will continue to supply both its own growing demand and new demand from Eastern Canada. After 2000, provincial exports are expected to drop because of declining production and growing Alberta needs.

Despite current oversupply, and the effects of the global recession, the ERCB expects the ready availability of gas in Alberta, at favourable prices, will continue to provide the opportunity for expansion of our petrochemical industry. By 2000, we foresee a doubling of the petrochemical industry's contribution to the provincial GDP. A strong industry producing products derived from petrochemicals also will have developed in proximity to the major petrochemical plants that produce ammonia, ethylene, and methanol. As a result, the petrochemical industry will be even more significant than it is today in such centres as Edmonton, Red Deer, and Medicine Hat.

The fortunes of coal, the sleeping energy giant, should also improve in the longer term. The growing need of the Pacific Rim countries to diversify their resource suppliers will benefit the Alberta coal producer. Coal exports will be double current levels by the year 2000, and will have generated considerable growth, especially in the Hinton area. The broader provincial industrial base expected by then will require a 70 per cent expansion of the electric energy industry, most of which will impact on the coal-fired power plants at Sheerness, Keephills, and Genesee. This growing need for electricity could also offer Alberta the opportunity to harness the very large hydro electric potential of the Slave River.

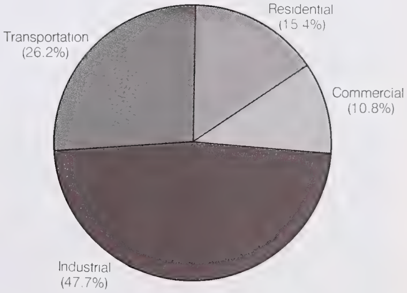
Considerable effort will have been made by 2000 — and with some success, we believe — to diversify the Alberta economy to include high technology industry, such as computers and telecommunications. Despite this expected diversification, the strength of Alberta's economy will remain tied to the production of primary energy. Alberta will continue to face a major trading challenge because of its relatively small population, its relatively high costs of production, and its distance from major markets. However, the province will, by that time, be even more prominent as a world leader in the development of oil sands technology, resource management techniques and the application of enhanced recovery technologies.

Alberta End-Use Energy Requirements



Total 0.8 Exajoules
1984

Chart 36



Total 1.3 Exajoules
2000

Chart 37

Revenues and Related Benefits

...from the Alberta energy stream

What Alberta's energy resources mean to the province and its people, in terms of revenue and employment, is explored in these four pages.

Alberta's energy resources generated total revenues of $25 billion in 1984 — a new record — and remained the major revenue producer in the provincial economy.

Increases in total revenues were generally due to greater production and to somewhat higher prices. Gross revenues continued their upward trend, as did investments and employment, the latter two recovering somewhat from the depressed levels of 1982 and 1983.

Gross revenue from oil — still Alberta's leading revenue generator — exceeded $15 billion. Revenue increases — from relaxation of qualifications for the higher oil price (NORP), and from increased sales volumes — greatly exceeded reductions in general pricing due to declining world oil prices.

Gas revenues were affected by several factors, including declines in export prices, escalations in Canadian prices, and higher sales volumes. However, overall revenue increased, as did that from natural gas by-products, including natural gas liquids and sulphur. Revenues from sulphur were

especially buoyant as a result of sharply higher prices, and the sale of 2.6 of the 14.7 million tonnes accumulated in inventory during poor market years.

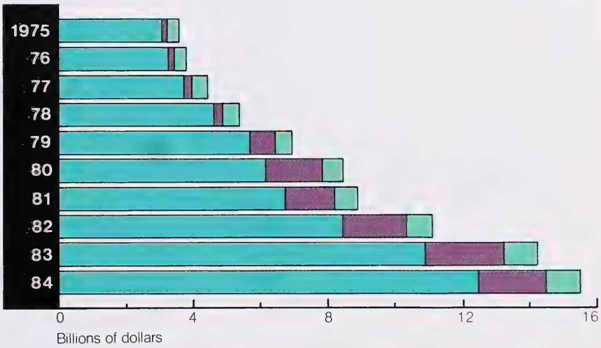
Gross revenue from coal also increased in 1984. Sales volumes of both bituminous and subbituminous coal were up, and average prices increased, although there were price changes both up and down within the industry.

Although statistics are incomplete on 1984 investment and employment in the energy industry, increases from 1983 levels appear to have occurred in both categories. Oil sands and conventional oil developments were the leading sectors, although new developments appear to have generated increases in both investment and employment in almost all energy sectors.

38 Gross Revenue — Oil

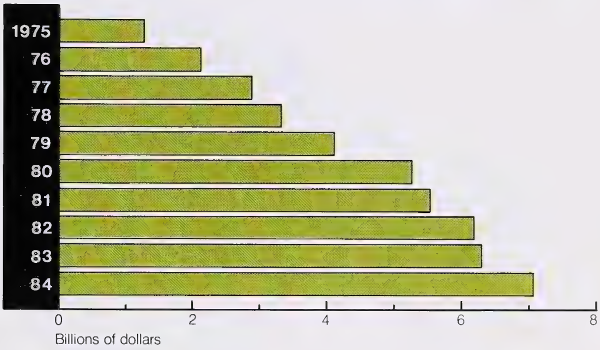
Crude oil (and equivalent) revenues increased 9 per cent, reflecting somewhat improved markets and better average prices.

- ▨ Conventional
- ▨ Synthetic
- ▨ Pentanes



39 Gross Revenue — Gas

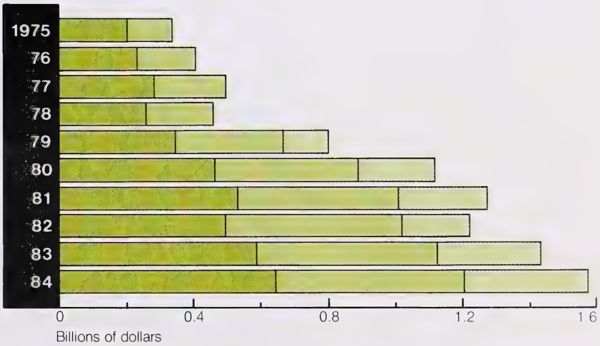
Gas revenues improved due to an increase in sales volume and slightly better average prices.



40 Gross Revenue — Natural Gas Liquids

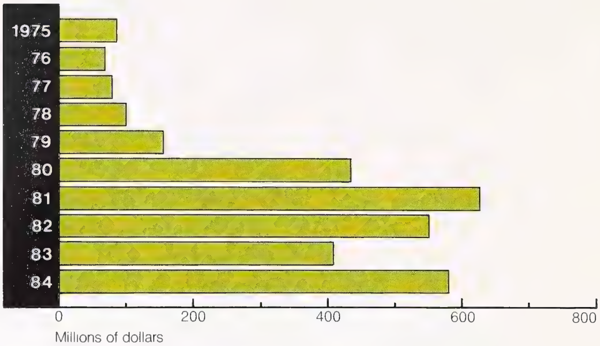
NGL revenues improved in 1984 due to increased sales volumes and a mixture of price changes, some up, some down.

- ▨ Propane
- ▨ Butanes
- ▨ Ethane



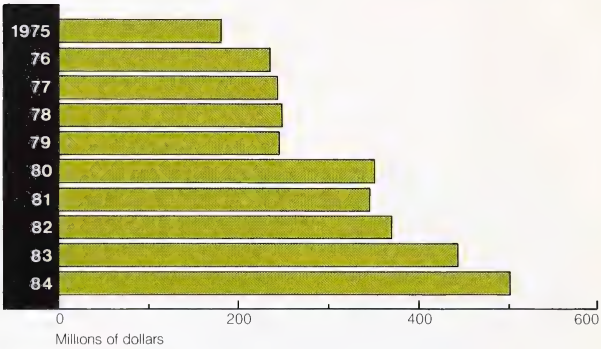
41 Gross Revenue — Sulphur

Sulphur revenues increased due to improved world markets and better prices.



42 Gross Revenue — Coal

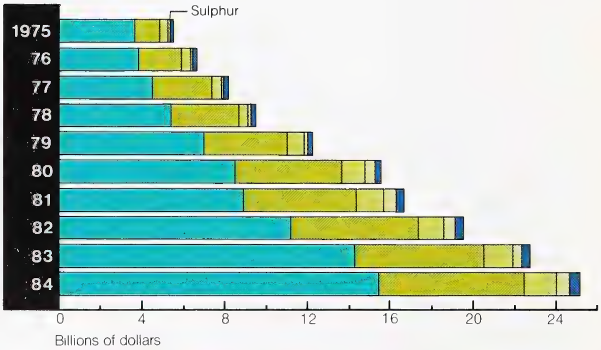
Coal revenues reflect an overall increase in both sales volume and prices.



43 Gross Revenues — All Hydrocarbon Energy Resources

Continued an upward trend in 1984, to almost $25 billion.

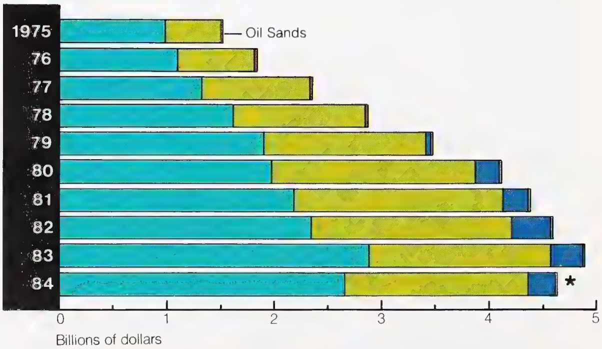
- 🟦 Crude Oil and Equivalent
- 🟨 Marketable Gas
- 🟨 Natural Gas Liquids
- 🟨 Sulphur
- 🟦 Coal



44 Government Energy Revenues — Royalties

Government receipts from royalties declined somewhat, but remained near $5 billion in 1984.

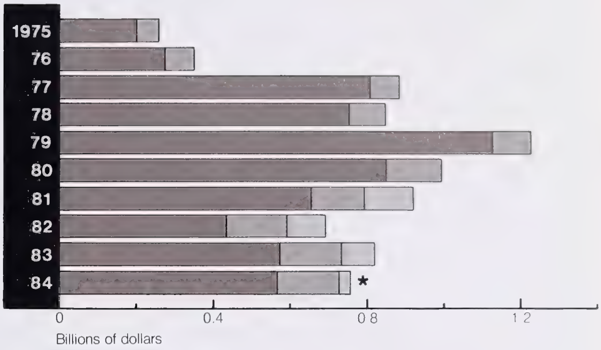
- 🟦 Crude Oil
- 🟨 Natural Gas and Products
- 🟪 Oil Sands
- 🟦 Coal
- ⬜ Other
- * Estimated



45 Government Energy Revenues — Other

Although down from earlier years, other government revenues from energy resources were about $750 million in 1984.

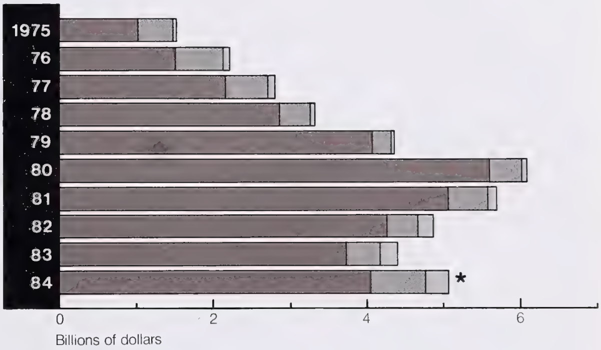
- ■ Rentals, Fees, Agreements and Sales
- ▨ Mineral Tax
- ░ Crude Oil Export Charge
- * Estimated



46 Energy Industry Investment

Investment appears to have recovered somewhat in all energy resource sectors in 1984.

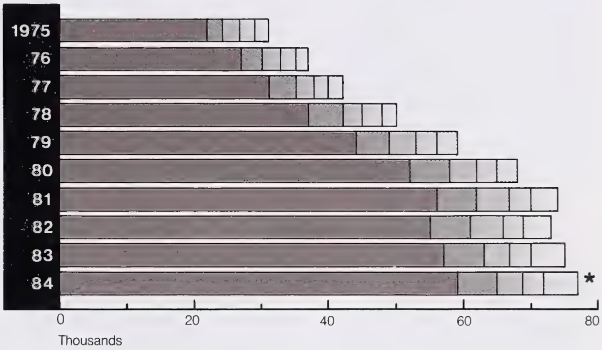
- ■ Gas and Conventional Oil
- ▨ Oil Sands
- ░ Coal
- * Estimated



47 Energy Industry Employment

Employment is estimated to have been at record levels in 1984.

- ■ Oil and Gas (Includes drilling and other services)
- ▨ Oil Sands
- ░ Electricity
- ░ Coal
- □ Petrochemicals
- * Estimated



Lakeland ENVIRONMENTAL
TECTION ASSOCIATION

Environmental Concerns

...and the Alberta energy stream

The development and production of energy resources inevitably results in environmental disturbances and impacts. For example, it is impossible to open large surface mines (which are necessary to recover Alberta's coal and oil sands resources) without causing major surface disturbances. Similarly, drilling for, and producing oil and gas results in both surface disturbances and the need to dispose of wastes.

While environmental impacts are inevitable — and are one of the costs or trade-offs of resource development — there is a need to ensure that those impacts are kept to a minimum; that they do not exceed acceptable levels. Which, of course, raises the question, "acceptable to whom?" — certainly a most controversial issue. Fundamentally, the definition of "acceptability" must rest with the elected government officials and government departments and agencies responsible for ensuring protection of the environment, and the health and safety of people. Input from the public is, of course, a major ingredient in determining these "acceptable" limits.

Alberta government departments and agencies have developed a comprehensive package of standards, monitoring systems, and enforcement techniques to control and limit environmental impacts. For example, the air quality standards in Alberta are the most stringent of those recommended by Environment Canada. Similarly, tough air quality requirements are imposed on Alberta processing plant operations.

From time-to-time, however, mechanical equipment will malfunction, and human beings will make mistakes. The following pages and charts report on those occasions during 1984.

One of the best-known cases was the Lodgepole blowout that occurred in October 1982. It resulted in large volumes of sour gas being emitted over a period of 68 days. In 1984, the Lodgepole Inquiry Panel issued its report on that event. That report recommended several changes in the procedures used for drilling difficult sour wells. Those recommendations were later adopted by the ERCB and inspections of drilling operations were increased, particularly for critical wells. Alberta's overall sour well drilling performance has improved since the Lodgepole incident.

Another area of special concern to many members of the public is the emissions that result from the processing of sour gas. In 1984, somewhat more than one-half the gas produced in Alberta required processing to remove hydrogen sulphide (H_2S). Almost 98 per cent of this H_2S was recovered in the form of elemental sulphur, but the remaining 2 per cent had to be incinerated and discharged to the atmosphere as sulphur dioxide. Those emissions have caused considerable public concern, even though Alberta's tough air quality standards are being fully met. In recognition of those public concerns, the Alberta Government, and the energy industry, have launched a comprehensive research program — called the Acid Deposition Research Program (ADRP) — that will cost about $8 million and require nearly seven years to complete.

Industry-sponsored oil spill co-operatives stand ready to work on spills into water. Members of the Lakeland Co-op (opposite) participate in a training exercise to skim oil from a river.

Alberta is crisscrossed with some 160 000 kilometres of pipelines and, periodically, leaks or breaks in those lines result in release of liquid hydrocarbons or salt water. In 1984, about 80 per cent of the liquid spilled was salt water produced with oil. Salt water is especially corrosive to pipelines, and each year a larger volume of salt water is produced with the oil. This situation creates an ever-increasing potential for pipeline leaks. However, new corrosion prevention techniques, and improved leak detection methods, are being developed to counteract this increasing problem.

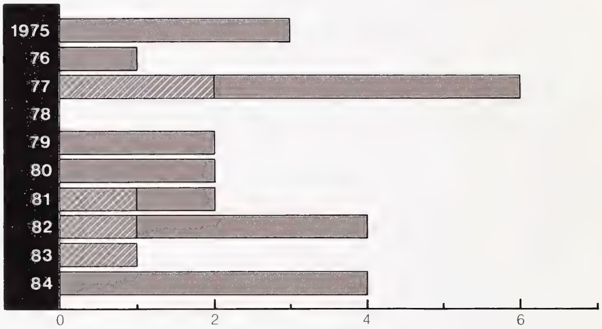
The volume of gas or liquids released from a pipeline depends on the nature of the failure (pin-hole leak, break, or rupture), and the elapsed time before the break is detected.

For pipelines transporting liquid hydrocarbons, or gas (whether sweet or sour), there are control measures to ensure that failures are quickly detected. In the case of sour gas, a pipeline failure automatically brings about a shut-down of the entire pipeline system.

48 Blowouts at Drilling Wells

Four blowouts occurred in 1984 while drilling almost 5700 wells. Each was minor and control was regained quickly. None occurred at sour gas wells.

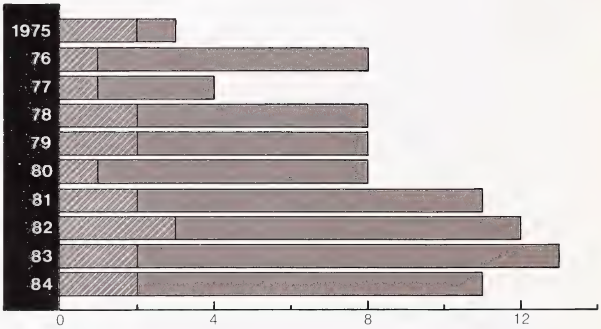
▨ Sour Gas Wells



49 Blowouts at Operating Wells

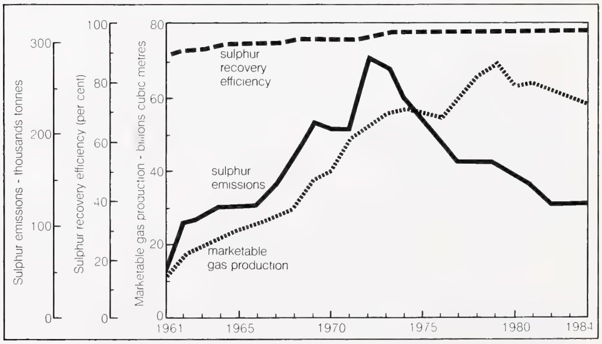
Eleven blowouts occurred in 1984 while operating more than 40 000 wells. Seven of the blowouts were oil wells and of the four gas wells, two were sweet and two were sour.

▨ Sour Gas Wells



50 Sulphur Emissions and Recovery — Sour Gas Plants

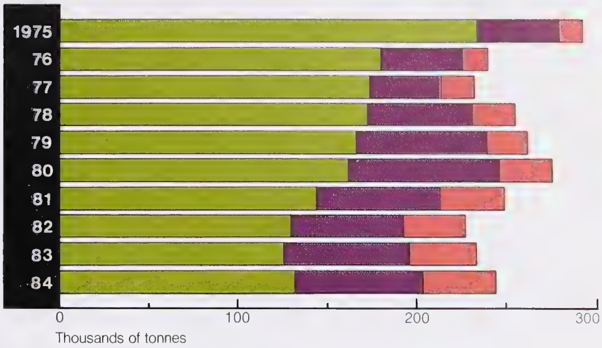
Sour gas plant emissions remained about the same as in 1983. Average sulphur recovery was almost 98 per cent.



51 Sulphur Emissions — Energy Resource Plants

The slight increase in total emissions in 1984 reflects increased resource processing. Emissions from plants were distributed; gas 54 per cent, oil sands 30 per cent, and power 16 per cent.

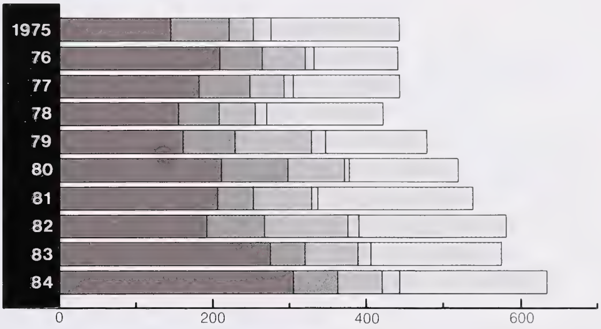
🟩 Gas Plants
🟪 Oil Sands Plants
🟧 Power Plants



52 Pipeline Leaks and Breaks — by Line Type

In 1984 there were 637 incidents — from pinhole leaks to major breaks — or 4 incidents per 1000 kilometres of operating pipeline. One-half of the leaks were salt water. Sour-gas pipelines accounted for 3 per cent of the leaks.

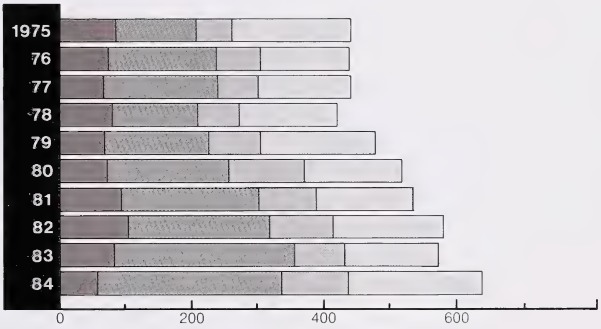
▇ Water
▨ Oil
▒ Sweet Gas
░ Sour Gas
□ Multiphase



53 Pipeline Leaks and Breaks — by Cause

Causes were mainly internal corrosion and third party damage. Corrosion, both internal and external, accounted for 361 incidents in 1984.

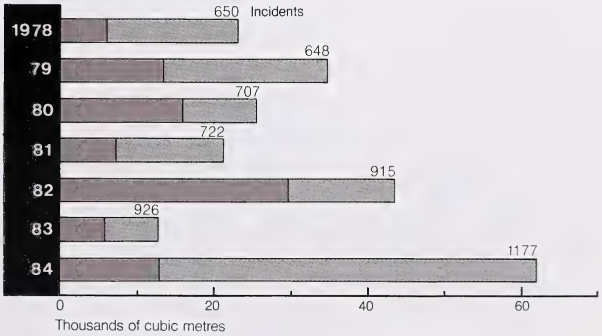
▇ External Corrosion
▨ Internal Corrosion
▒ Third Party Damage
□ Other



54 Liquids Spilled

Both the number of incidents, and the total volume spilled, increased in 1984. A single break in a salt water pipeline accounted for more than one-half the total liquids spilled. Fortunately it occurred in a remote unsettled area and did not cause serious damage.

▇ Liquid Hydrocarbons
▨ Salt Water



Energy Resources Conservation Board

...its work in the Alberta energy stream

The ERCB plays a unique and pivotal role in the development of Alberta's energy resources. In this section we have provided the reader with a brief sketch of ERCB's responsibilities, how it operates, and what ERCB people were doing during 1984.

ERCB Responsibilities

The reason for the ERCB, and the specific responsibilities assigned to it, can be found in eight Alberta statutes. The responsibilities are broad and cover most areas of the energy industry. They include such matters as reviewing all proposed energy facilities, estimating provincial energy resources, ensuring optimum recovery of resources, and examining potential markets. The ERCB also is required to ensure that operations in the industry are carried out safely, in a manner that will control pollution, and in the public interest.

The Energy Resources Conservation Act specifies how the ERCB must conduct its operations and, in particular, the safeguards that must be applied during the ERCB's review of proposed energy facilities. The Act requires the Board to give notice to any person who might be directly and adversely affected by a proposed energy facility and, if that person objects to the proposed development, an opportunity to ask questions and present evidence.

Several of the statutes which prescribe ERCB responsibilities are supplemented by extensive regulations which provide industry with its basic operating rules. The ERCB also ensures that actual operations are carried out in compliance with those regulations.

Additionally, the Board is assigned the task of gathering, processing and disseminating technical and other information relevant to the energy industry. This includes a responsibility to provide the government, and the public, with information and advice regarding energy matters.

In summary, the ERCB's responsibilities are:

1. reviewing and deciding on applications for new energy projects
2. regulating the operation of existing energy facilities
3. providing advice and information to industry, the public and government.

In order to carry out these responsibilities, ERCB employs professionally qualified and experienced personnel who are located in the ERCB head office, in Calgary, and in 9 field offices throughout the province.

Organization and Finances

The ERCB organization consists of six Board members, 14 departments, and several specialist advisors. As shown in Chart 55, the departments may be categorized as resource, service and administration.

Funding of ERCB activities comes from two sources, in about equal portions; a direct grant from the government, and revenues from an administrative levy on operating wells in the province.

1984 Activities

The ERCB received about 12 700 applications for new energy facilities in 1984. About 90 per cent were either to drill a well, or construct or operate a pipeline. The total level of application activity increased significantly, compared to 1983, primarily because of the 45 per cent increase in well applications. However, overall activity was still somewhat less than the peak year of 1980.

As stated earlier, the Board must give notice to any person who might be directly and adversely affected by a proposed energy facility. Persons who might be so affected include both other companies active in the industry and local residents. When the Board receives objections to a proposed facility, it convenes a public hearing to provide interested persons with an opportunity to ask questions and present evidence. In 1984, ERCB held 68 public hearings, of which 46 per cent were to consider the concerns of the public (primarily people living in the area of the proposed project) and the balance to consider the concerns of industry.

The number of public hearings was somewhat greater than in 1983. While there was considerable variation among them, they typically required about 1.5 days, with those in which the public was involved lasting one additional day. Chart 56 shows ERCB's public hearing record over the last 14 years.

ERCB time

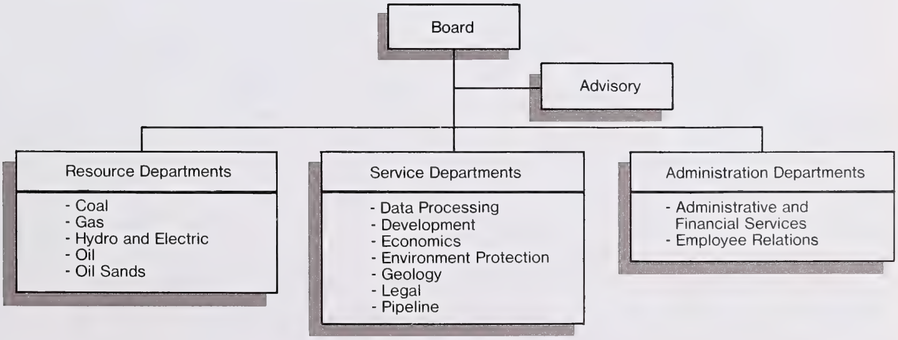
In 1984, about 18 per cent of total ERCB staff and Board time was devoted to reviewing applications, conducting related public hearings, and making decisions regarding new energy facilities. Management of energy resources, to ensure optimum recovery, required 22 per cent, while site inspections, by a field staff of 84, accounted for 13 per cent. The gathering and dissemination of a broad range of energy information accounted for 24 per cent of ERCB activities, while a further 9 per cent was due to providing advice — particularly to the government on technical matters. Managing ERCB's total operations (including its staff of 776 persons) accounted for 14 per cent of available time, of which about one-quarter was due to the extensive printing and graphics activities arising from ERCB reports and administrative orders.

The distribution of ERCB's 1984 time, by activity, is shown in Chart 57.

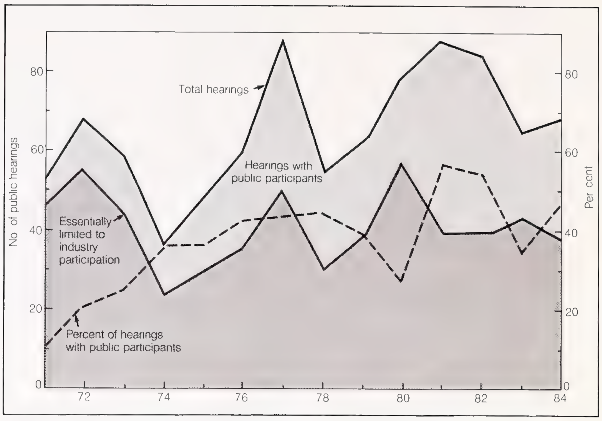
ERCB Expenditures

The total cost of ERCB operations in 1984 was some $37.4 million, about the same as in 1983. As shown in Chart 58, total staff has remained constant over the last three years, as have total expenditures. The cost of ERCB's operations also can be expressed on the basis of units of oil production. In 1984, the cost was 32 cents per equivalent cubic metre of oil produced (5 cents per barrel) which is slightly less than in 1983.

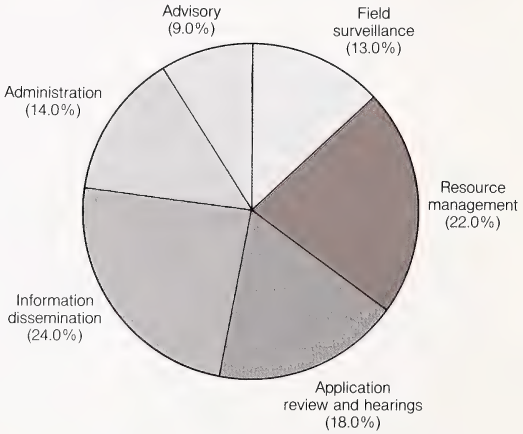
55 Organization Chart



56 Public Hearing Record

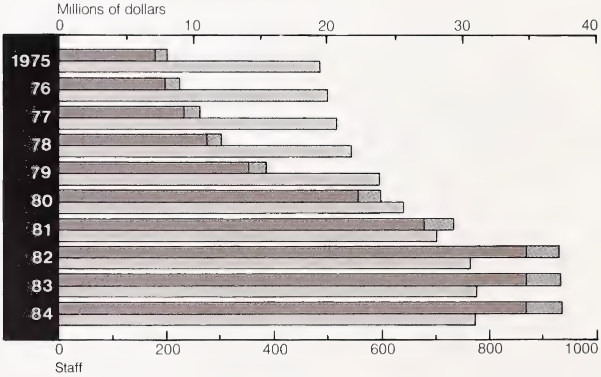


57 ERCB Time by Activity



58 ERCB Expenditures and Staff

▨ Oil, Gas and Related
▨ Hydro and Electric and Coal
▨ Staff



Energeum... Where Energy Fascinates!

If the visitors to ERCB's Energeum are typical, Albertans are not only energy conscious, they want to know more. They want to understand the connections between the refinery at the city's edge, the nodding pumpjack on the prairie field, and the remnants of the coal mine in the Badlands. Moreover, many Albertans are keenly interested in the future of energy developments, and in how those developments may affect their livelihoods and lifestyles.

Until recently there was no single place where Albertans could go to fit the pieces of the energy puzzle together. No place to discover the fascinating details of Alberta's energy picture. That is, not until January of 1983, when the ERCB officially opened the Energeum on the main floor of its Calgary head office.

As part of the Energy Resources Conservation Board, the Energeum is dedicated to "increasing public awareness, understanding, and appreciation of energy matters".

The name Energeum combines "energy" with "museum". But, it's a museum only in the spirit of modern-day science centres. That is, it invites visitors of all ages to become involved in hands-on, computer-age displays.

In the Energeum's 4000 square feet of display space, the visitor encounters, first, the forces of geological time. Models, fossils, and graphics help dispel some popular misconceptions about how and where fossil fuels are found. Later, if the visitor has learned his or her lessons well, the "risks" involved in drilling with the Wildcat computer game should turn into success.

Part of the historical development of energy in Alberta is told through the actual voices of some of Alberta's energy pioneers and entrepreneurs. Their optimism is captured in Energeum's centrepiece, a pink 1958 Buick

convertible, one of the nostalgic symbols of the dream of unlimited energy widely held in the 1950s.

And finally, where does Alberta's energy end up? In the homes and cars and work of people all across Canada. "Energy Audit" and "Energy Hangman" are only two of Energeum's computer games designed to make individuals more aware of their own place in the total energy picture.

Visitors and Programs

During 1984, 26 000 people visited the Energeum. Half of these were in organized groups. Also, demand is increasing steadily for Energeum's curriculum-based programs for school groups, with 9000 students from across Alberta visiting Energeum during 1984.

Special events, such as the annual celebration of "Sun" day (June 21), thought-stimulating film presentations, and a new guest-lecturer series, were increasingly well-attended, making the Energeum a vibrant addition to Calgary and Alberta.

Volunteers

Energeum owes much of its success as a visitor attraction to its volunteer hosts and hostesses. This program, which began with 3 volunteers in 1983, now has 25 people who contribute an average of 3 hours per week each, working primarily with visiting school groups. Energeum's volunteers provided more than 1000 hours of expertise and assistance during 1984.

The entrance sculpture in ERCB's Energeum is a lively and attractive mobile entitled "Wonderful Energy Machine". It shows the earth as the storehouse of the sun's energy, which man then uses in the forms of oil, gas, coal, and hydroelectricity.

Richard Prince, creator of "Wonderful Energy Machine", is a sculptor with a penchant for including humour and mechanical devices in his work.

ERCB Senior Management — 31 December 1984

Board Members

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G.J. DeSorcy	Vice Chairman
L.A. Bellows	
V.E. Bohme	
C.J. Goodman	
N. Strom	

Senior Advisors

G.A. Warne	Technical Assistant to the Board
J. Bales	Communications Advisor

Managers	**Departments**
K.W. Fuller	Administrative and Financial Services
R.G. Paterson	Coal
H. Antonio	Data Processing
E.J. Morin	Development
F.J. Mink	Economics
R.F. Braun	Employee Relations
E.R. Brushett	Environment Protection
H.J. Webber	Gas
J.R. Pow	Geology
T.F. Homeniuk	Hydro and Electric
M.J. Bruni	Legal
J.A. Bray	Oil
R.G. Evans	Oil Sands
E.G. Fox	Pipeline

Acknowledgements

The Board wishes to acknowledge the valued advice and counsel of George Warne, Mel Stowko, Jack Bales, Barry Scott and Walter Casselman in preparing this report.

Additional information on ERCB and its activities may be obtained from:

Information Services
297-8190 or 297-8328
A publications catalogue is available free of charge.

ERCB Library
297-7308

Communications Office
297-3596

All three are located in the ERCB Head Office, at
640 -5th Avenue, S.W., Calgary, Alberta T2P 3G4.